

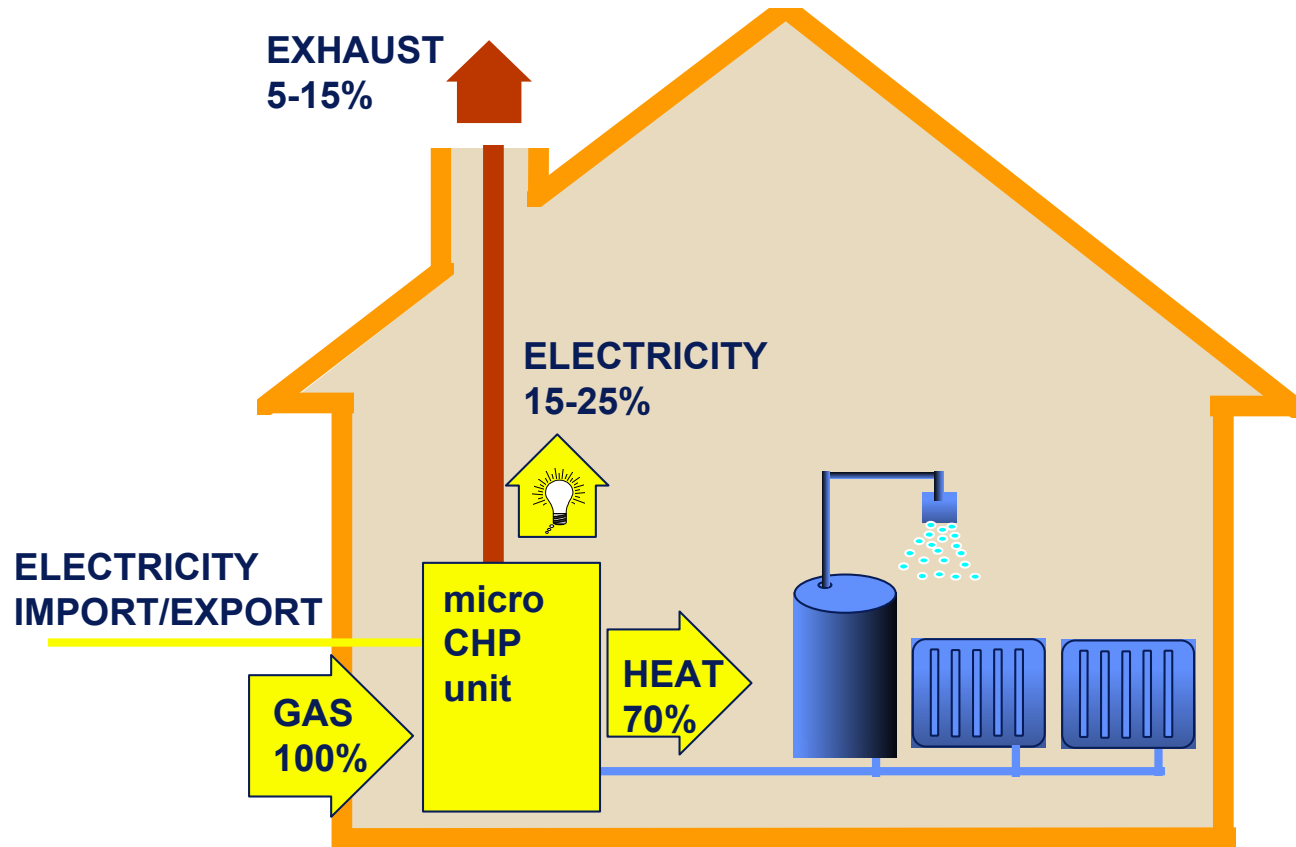
Micro CHP in Europe

Jeremy Harrison
EA Technology

Definition of micro CHP

- *“A direct replacement for a boiler in a hydronic heating system, which simultaneously produces heat & electrical power”*
- G83/CEN technical definition
 - “generator with rated output of $\leq 16\text{A}$ per phase”
- DCHP functional definition
 - “one unit per home”

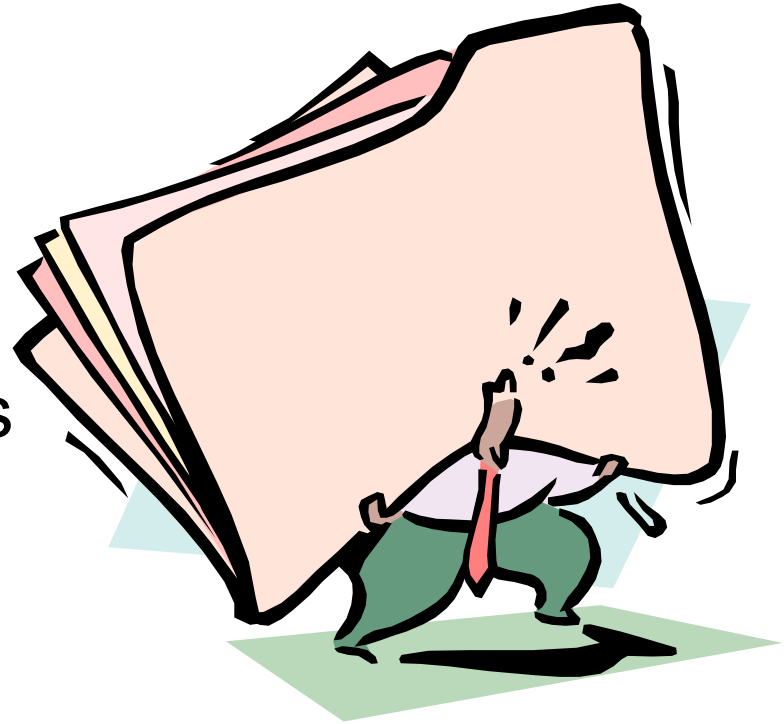
Micro CHP concept



Micro CHP replaces boiler in conventional central heating system

Requirements for micro CHP

- noise, vibration
- size, weight
- capital cost
- service cost/intervals
- heat/power ratio
- running hours



Potential UK impact of DCHP

- 15-22GWe installed capacity
- equivalent to nuclear capacity (not output)
- 12 million suitable homes in UK
- 67 million tonnes CO₂ reduction annually
- ~250,000 p.a by 2010
- 1,000,000 installed systems by 2010
- ~2 million tonnes CO₂ p.a. by 2010

Potential EU impact of DCHP

- 60GWe installed capacity
- equivalent to nuclear capacity (DE, UK)
- 40 million suitable homes
- 200 million tonnes CO₂ reduction annually
- 1 million installations p.a by 2010
- 15 million tonnes CO₂ p.a. by 2010

Impacts on Distribution Networks

- Loss of revenue
- Additional effort
 - Incentives
- Design & operation of network
- Standard of supply
 - CI/CML (DCPR)
 - Power quality
 - Security of supply (P2/6)
- Safety

Connection to network

- Previous system (G59) too complex
- Type approved products/interfaces
- Certified installers
- Notification
- Progress so far
 - UK draft engineering recommendation (G83)
 - European (CEN) workshop agreement
 - CENELEC in progress

Connection to network - who pays?

- **DNO = all customers**
 - natural route for natural monopoly?
 - public service
- **Individual micro CHP operators**
 - highly complex
- **All micro CHP operators**
 - equitable
 - incorporate in tariff

Connection to home

- Thermal: “drop-in” replacement
- Electrical
 - Fusing
 - Connection to ring main (UK)
 - Connection to cooker spur (or other high rated spur)
 - Avoiding nuisance trips - network support
- Metering & control
 - Integration with controls (load management)
 - Remote metering

Economic case for micro CHP

- marginal investment cost recovered by value of generation +/- marginal gas consumption
 - marginal cost depends on production cost
 - generation depends on running hours
 - marginal gas consumption depends on technology (heat:power ratio, η_t)
- importance of “spark spread” - future price volatility
- value of location (time & space)

Cost/value recovery



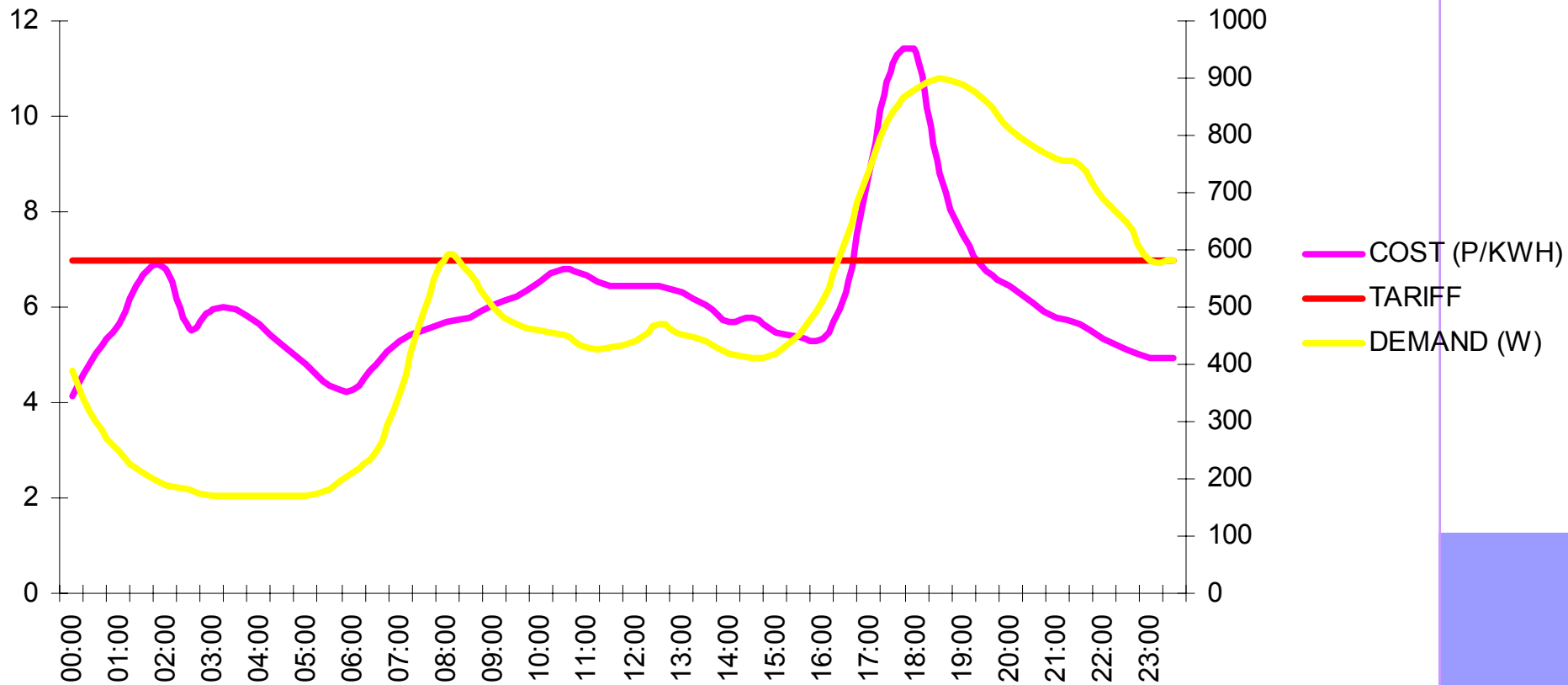
- Metering
- Settlement
- CCL exemption
- ROC accreditation
- Emissions Trading
- Balancing market/volatility
- Aggregation of export

Energy trading options

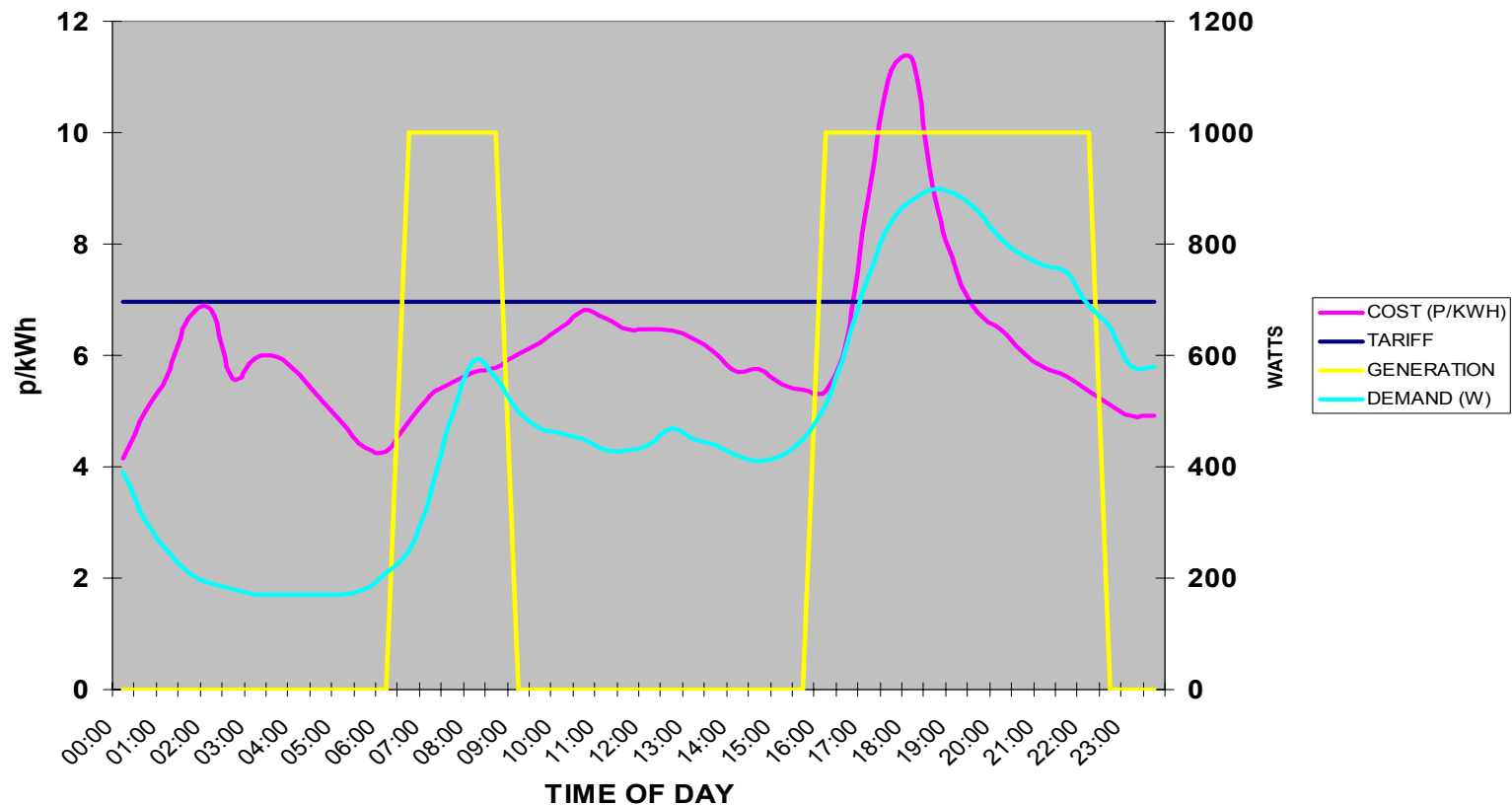


- Metering
 - Existing + assumption
 - 2-way (import/export)
 - Half-hour
 - Smart-settlement
 - Net
- Settlement
 - Profile (diversified)
 - Aggregation

Profile settlement: supply



Coincidence of high cost with micro CHP generation (domestic)



Characteristics of micro-generation

POWER: HEAT & EFFICIENCY

	kW_e:kW_t	η el.	η total
Stirling	1:3-1:8	12-30%	90-95%
Fuel cell	1:1-1:3	20-35%	~80%
ICE	1:2-1:3	25-35%	85-90%

Technology status: ICE

- Senertec (5.5kWe)
- Ecopower (5kWe)
- Cogenics (3-5kWe)
- Honda (1kWe)



Technology status: Fuel Cells



VAILLANT (5kWe) *PEM*

EUROPEAN FUEL CELLS
(1.5kWe) *PEM*

Johnson Matthey *PEM*

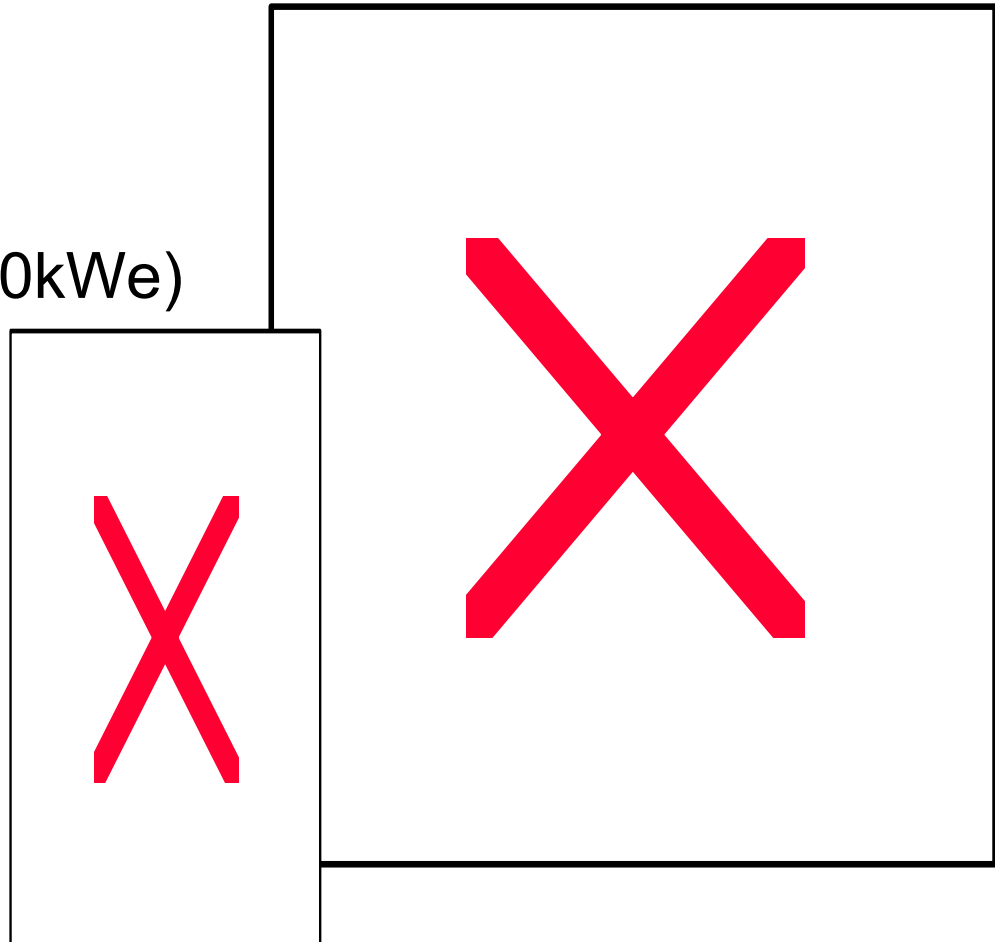
Sulzer HEXIS (1kWe) *SOFC*

Baxi technologies fuel cell



Technology status: Rankine cycle

- Cogen Micro
(2.5kWe/12kWt)
- Inergen (1kWe/10kWe)
- Climate Energy
- Enginion



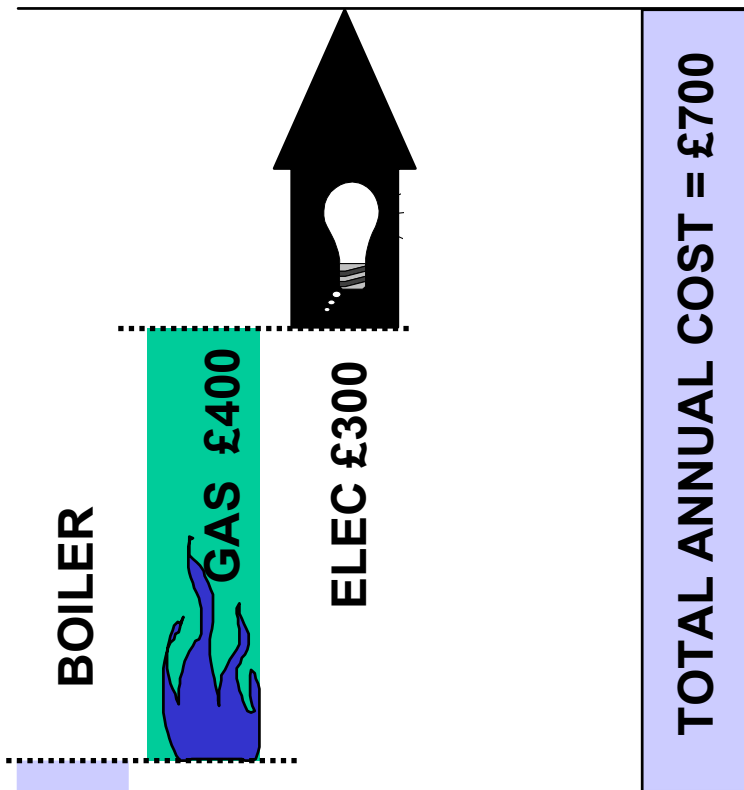
Technology status: Stirling engine

- Whispertech
(1kWe/8kWt)
- BG Microgen
(1kWe/45kWt)
- Sigma (3kWe/9kWt)
- ENATEC
(1kWe/45kWt)
- SIG (1kWe/?)

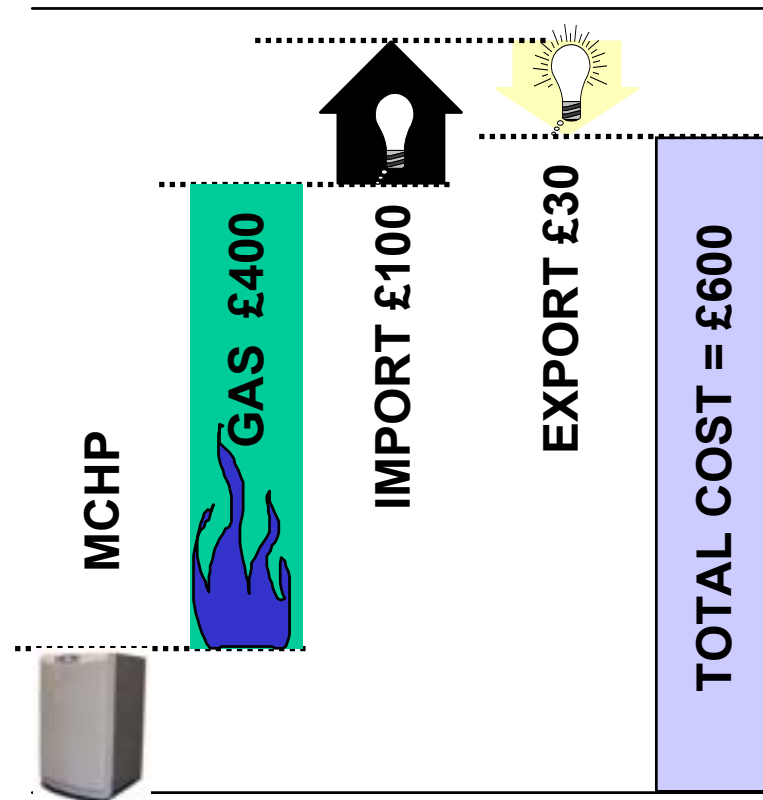


SE micro CHP economics*

CONVENTIONAL BOILER
20 000kWh THERMAL DEMAND



1 kWe SE MICRO CHP UNIT
4 500kWh ELECTRIC DEMAND



* marginal cost basis-end user economics

EA Technology field trials

- 1990 feasibility study
- 1999 laboratory trials & evaluation
- 2000 sheltered trials (5 units)
- 2001 alpha trials (20 units)
- 2002 beta trials (30 units)
- 2003 “commercial” trials?

SKIP

2002-2003 TRIALS

- 30 installations
- 15 Ipswich area (E)
- 15 Chester area (NW)
 - 10 existing
 - 5 new
- Mix of sizes, ages, constructions and occupancy





Example trial house

- 138m² total floor area
- three storey - living on mid floor
- built 1998
- insulation to Building Regulations
- usage pattern
 - continuous occupancy
 - copious showers



Original heating system

- Wall-hung boiler in kitchen (mid-floor)
- Y-plan (3-port valve)
- Single zone
- 7-day programmer
- room/cylinder thermostat



Micro CHP system

- MK III WhisperGen
- Directly below boiler in kitchen
- Integral G83 LOM protection
- Controlled from existing programmer (run signal)
- Remote data logging and on-line diagnostics



Economics (nominal)

• Annual gas bill	£	550
• Annual electricity bill	£	450
• Annual gas consumption	kWh	35 000
• Annual space heat	kWht	18 000
• Annual DHW	kWht	6 000
• Annual electric consumption	kWh	6 000
• Generation	kWhe	3 400
• Projected savings	£	150-200

Environmental comments

- will target CO₂ savings be achieved?
 - higher mean internal temperature (MIT)
 - more likely to mitigate increase in energy demand than actually reduce it?
- target market (not fuel poor)
 - % savings
 - comfort factor



Field trial conclusions

- Raises awareness of pre-existing shortcomings
- Anticipated energy savings may lead to higher comfort demands and consequently lower savings
- Need to target customers carefully and give clear message about what micro CHP will or will not do for them
- Excellent service support essential

What happens next?

- Live market test
 - partnership with housebuilder
- 400 systems to be sold in 2003
- New-build with thermal store
 - improves performance
 - simplifies installation
- Need for ongoing monitoring
 - profile settlement (economic)
 - SEDBUK, EEC etc (environmental)

Compliance & incentives

- Mandatory standards
 - Product (CE marking, applicable directives)
 - Network connection (G83, CWA)
 - Domestic connection (IEE, SEDBUK)
- Desirable “passport to benefits”
 - CHP QA
 - CCL exemption
 - Enhanced capital allowances
 - SEDBUK/EEC
 - EEC eligibility
 - *Renewables* obligation eligibility?

Obstacles

- Technical standards and procedures
 - G83 is great simplification
 - environmental accreditation
- Metering, settlement and trading
 - OFGEM currently seeking appropriate solutions
 - no problem if 100% auto-consumption
- Skills shortage
 - across industry
 - SBGI working group
- Implications for DNO, suppliers etc.

Things to avoid

- Complexity - CHPQA
- Discriminatory charging
- Net metering
 - Unsustainable
 - Encourages lazy thinking & inefficiency
 - Lame duck support
 - Raises (understandably) incumbent hostility
 - Does not reflect true micro CHP value
- Inaction

Conclusion

- Micro CHP is economically viable now
- Emerging technologies and new products will make micro CHP even more cost-effective
- Government incentives will further enhance CHP economics
- Simplified connection and trading will remove technical and economic barriers